DURABILITY OF LIGHTWEIGHT AGGREGATE CONCRETE CONTAINING OIL PALM ASH (OPA)

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Malaysia Pahang or any other institutions.

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ABSTRAK

Di Malaysia, industri minyak sawit yang telah berkembang pesat sepanjang tahun telah menyebabkan penghasilan sisa dalam kuantit yang besar dan akan menjejaskan alam sekitar secara negatif. Penghasilan bahan binaan seperti simen dari sumber semulajadi telah menyebabkan banyak penghasilan gas-gas yang tidak perlu secara berlebihan ke udara boleh menyebabkan kesan rumah hijau terhadap alam sekitar. Debu Minyak Kelapa Sawit (OPA) merupakan salah satu jenis sisa industri minyak kelapa sawit – yang boleh didapati dengan mudah, akan digunakan dalam penyelidikan ini bagi membantu dalam mengatasi masalah pencemaran ini secara minor. Ketidaktentuan prestasi bagi kandungan konkrit ringan, penyiasatan dari segi ketahanan terhadap serangan asid dan sulfat dan penyerapan air akan dibuat. Lima siri 0%, 10%, 20%, 30% dan 40% kandungan konkrit ringan OPA dengan saiz campuran kiub yang sama (100X100) mm^2 akan disediakan. Spesimen dengan 0% kandungan OPA akan menjadi spesimen kawalan bagi siasatan ini. Spesimen konkrit ringan ini akan melalui temppoh pengawetan selama 28 hari iaitu selama 7 hari di dalam air dan selebihnya akan dibiarkan terdedah ke udara. Kehilangan berat spesimeen akan diperhatikan berkaitan bagi ujian rintangan asid dan sulfat. Kemerosotan kekuatan akan diperhatikan bagi ujian rintangan asid. Seterusnya, kadar penyerapan air akan diperhatikan bagi ujian penyerapan air. Hasil ketara yang diperolehi menyimpulkan bahawa dengan kandungan OPA yang semakin meningkat, berat spesimen semakin berkurang daripada berat asal dan kekuatan spesimen turut menjadi semakin merosot. Kadar penyerapan air juga semakin meningkat apabila kandungan OPA meningkat. Kesimpulannya, kesan negatif terhadap spesimen terjadi kerana kandungan OPA banyak, serta, melebihi kandungan optimum OPA yang sesuai menggantikan semen.

ABSTRACT

In Malaysia, the industry of palm oil has grown rapidly throughout the years causing an immense production of waste that will surely affect the environment negatively. The production of construction material from natural resources such as cement has produced an excessive amount of unnecessary gas into the air causing a blunt greenhouse effect on the environment. Oil Palm Ash (OPA) as one types of palm oil industrial wastes – can be easily obtained, were used in the research that in order to help in overcoming these problems. In regard of its uncertain performance as a content of lightweight concrete, an investigation in terms of durability against acid and sulphate attacks and water absorption were also made. Five series of 0%, 10%, 20%, 30% and 40% of OPA content lightweight concrete with the same mix proportioning of (100X100) mm^2 cube size were prepared. The specimen with 0% content of OPA was set as the control specimen of the investigation. These lightweight concrete specimens were then cured for 28 days – 7 days in water and the rest will be air cured. Losses of mass was observed in regard of acid and sulphate resistance test. Strength deterioration in regard of acid resistance test. While, in water absorption rate, the water absorption test were necessarily observed. The distinct result obtained concluded that with the increasing content of OPA, the specimens become susceptible to loss mass as compared to its original mass and deteriorate in strength. The water absorption rate observed also increase as OPA content increases. It is concluded that, all these negative effects on the specimens were only observed when the content of OPA is too much and exceeded the optimum content of OPA.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

℃	Degree Celsius
%	Percent
μm	Micro-meter
C-S-H	Calcium Silicate Hydrate
$Ca(OH)_2$	Calcium Hydroxide
d	Day
ft	Feet
in	Inches
kg	Kilogram
kN	Loadings
lb	Pound
m	Metre
mm	Millimetre
Mpa	Strength (Mega-Pascal)
SG	Specific Gravity
$MgSO_4$	Magnesium Sulphate

LIST OF ABBREVIATIONS

OPA	Oil Palm Ash
POBS	Palm Oil Boiler Stone
LWC	Lightweight Concrete
LWAC	Lightweight Aggregate Concrete
SSD	Saturated Surface Dry
USA	The United State of America
YTL	Yeoh Teong Lay
UMP	University Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 Background of Research

Concrete – commonly known as a major material in construction – is the mixture of cement, coarse and fine aggregates and with or without chemical-mineral additives. Being able to replace some of these materials could make significant changes to the environment and cost as well as the performance of the concrete themselves (Kanchidurai et al, 2017). Through a hydration process that binds the aggregates together the mortar – mixture of concrete ingredients, develops into becoming hard, durable and strong material. Depending on the content of the aggregate, the durability of the concrete would vary. The mixture of concrete with some lightweight coarse aggregate made up a lightweight aggregate concrete mixture. Typically, the density of lightweight concrete would be a lot less compared to the normal weight concrete. This is because, light weight structural concrete is an enhanced version of concrete, with emphasis on decrease in density of concrete, hence, when structural concerns require a minimum to the dead load, light weight concrete is used (Rasheed & Prakash, 2015). So, practically, the primary use of lightweight concrete is to reduce the dead load of a concrete structure.

Malaysia as one of the developing country in term of oil palm industry, have generate bunches of palm oil wastes. The most common wastes from palm oil mill is Oil Palm Ash (OPA) and Palm Oil Boiler Stone (POBS) are by-products of oil mills arising from the use of palm oil shell and palm oil bunches which are used to power oil mill plants for electricity generation (Awal and Hussin, 1997; Hussin et al., 2010). Each year, more than 100,000 tons of OPA is produced and is increasing annually, while the utilization of it is minimal. Thus, most of these oil palm waste will be disposed of in landfills, causing environmental and other problems (Jaturapitakkul et al., 2007). Its

abundant in amount made it an easier option for material replacement as it is easily available. Besides, there is also a research conducted to have shown that these palm oil wastes can be used as material in the manufacture of concrete (Teo, et al., 2006). Based on World Business Council for Sustainable Development in the year of 2006, the cement industry produces about 2.6 billion tonnes of cement annually. The most important use of cement is in the production of concrete, twice the amount of which is used than the total of all other building materials, to construct our homes, schools, hospitals, sewage systems, pavements and more. Concrete is the most used man-made material in the world, a fact not widely known. Concrete has a cement content of between 10-15%. The excessive use of natural resources could be reduced significantly through this integration.

Considering the amount of OPA arising from palm oil mills in Malaysia, Thailand, Indonesia and other palm oil producing nations and the desire to address environmental problem posed by this waste, there is a need to examine further on the application of OPA at higher volume particularly in concrete operations. As such there have been lots of previous researchers that have reported various studies that shows OPA is as suitable to be use in the mixture of concrete (Chindaprasirt et al., 2008; Wongkeo et al., 2014; Deboucha et al., 2015). OPA has a lot of time been introduced as a pozzolanic material in concrete and there have been a lot of studies that focussed on OPA in the study of its mechanical properties in concrete such as compressive strength and modulus of elasticity of concrete. Some studies have considered the durability of these mix of concrete against sulphate attack and corrosion resistance of high-strength concrete (Chindaprasirt, et al., 2011). With the increasing needs to substitute the construction into an eco-friendlier environment, a proper study about any integrations toward that objectives should be made. So, it seems more than appropriate and beneficial to conduct a further study on the durability performance of lightweight concrete containing OPA.

1.2 Problem Statement

In construction industry, the act of building a shelter from scrap involve a lot of uses of machines, natural resources and cost. So, there have been a concern about how to improve construction practices to minimise their detrimental effects on the natural

environment (Cole, 1999).Construction contributes to air pollution at all levels. It creates air pollution at a local scale through emissions of dust, fibre, particles and toxic gases from site activities and building materials production processes. It contributes to regional pollution through emissions of nitrogen and sulphur oxides in building materials production (Spence et al., 1995). Being the major user of the world's non-renewable energy sources and minerals, the construction industry has contributed a lot in causing pollution on the earth. Apart from that, an improving palm oil industry is also among the largest industry to contribute waste. Such as in Malaysia, its excessive production of waste from the palm oil industry has affected the sustainability of the country. Too much waste contributes to landfills and a higher possibility of causing a lot more pollution to the environment. This is because, the incineration of palm oil ingredients could release abundantly unnecessary smoke or gas to the atmosphere that will pollute the air. Therefore, the integration of palm oil industry by-products such as OPA and POBS as partial material replacement in the manufacture of concrete can decrease the use of natural resources, while also contributing to the reduction of pollution to the environment.

1.3 Research Objective

The objectives of the research are as follows: –

i. To investigate the effect of Oil Palm Ash (OPA) as mixing ingredient on sulphate attack of lightweight concrete.
ii. To investigate the effect of Oil Palm Ash (OPA) as mixing ingredient on acid resistance of lightweight concrete.
iii. To investigate the effect of Oil Palm Ash (OPA) as mixing ingredient on water absorption of lightweight concrete.

1.4 Significance of Research

The main purpose of conducting this research is to contribute in decreasing the pollution of the environment. With the excessive development and demand from the agricultural industry, lots of by-products or waste were involuntarily produce that can affect the environment. Sustainability of the construction industry is kind of the major issue that need to be immediately focused on. Therefore, the ability to properly reuse or

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